

Specific ICD Behavior

Thomas Brüggemann

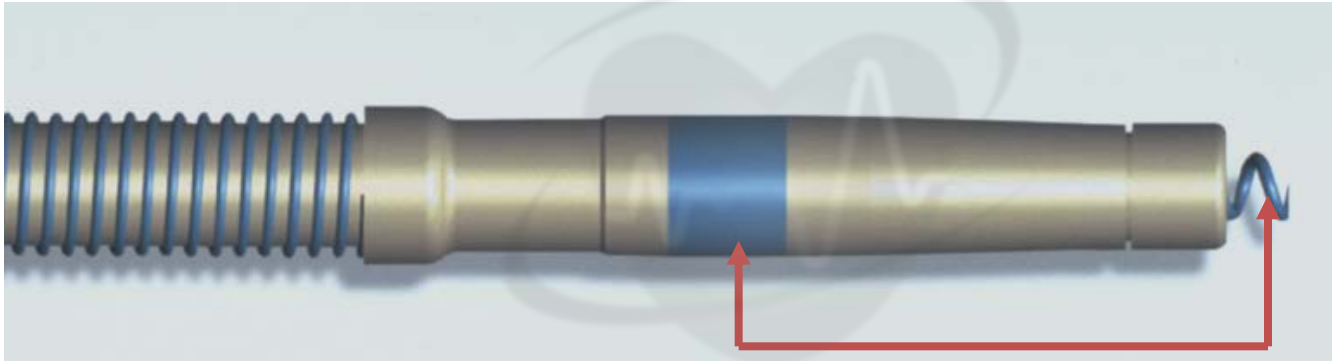
EHRA Devices Course
Vienna, 8-10 March 2012

Specific ICD Behavior - Agenda

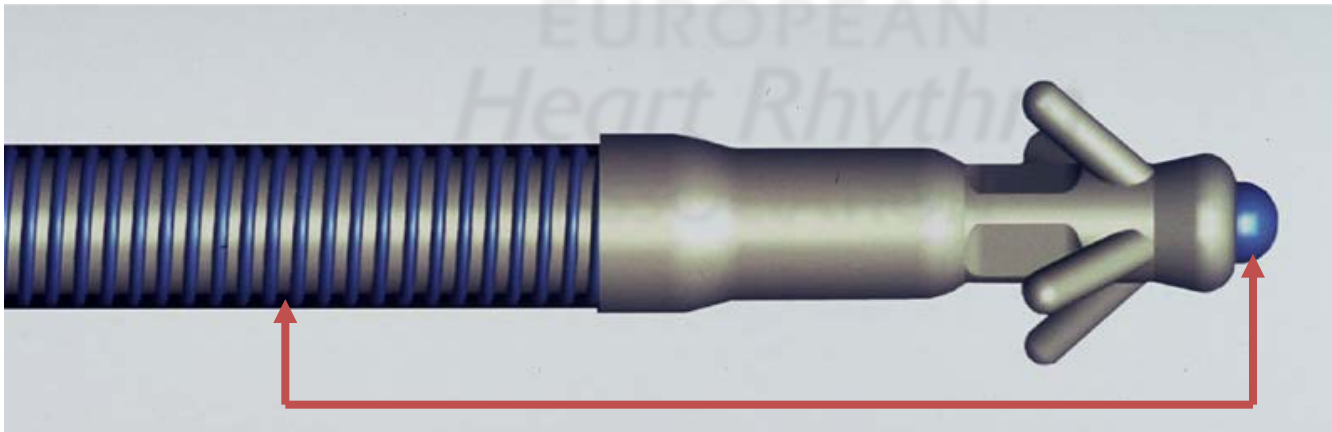
- Sensing
- Detection
- Therapy



ICD Sensing

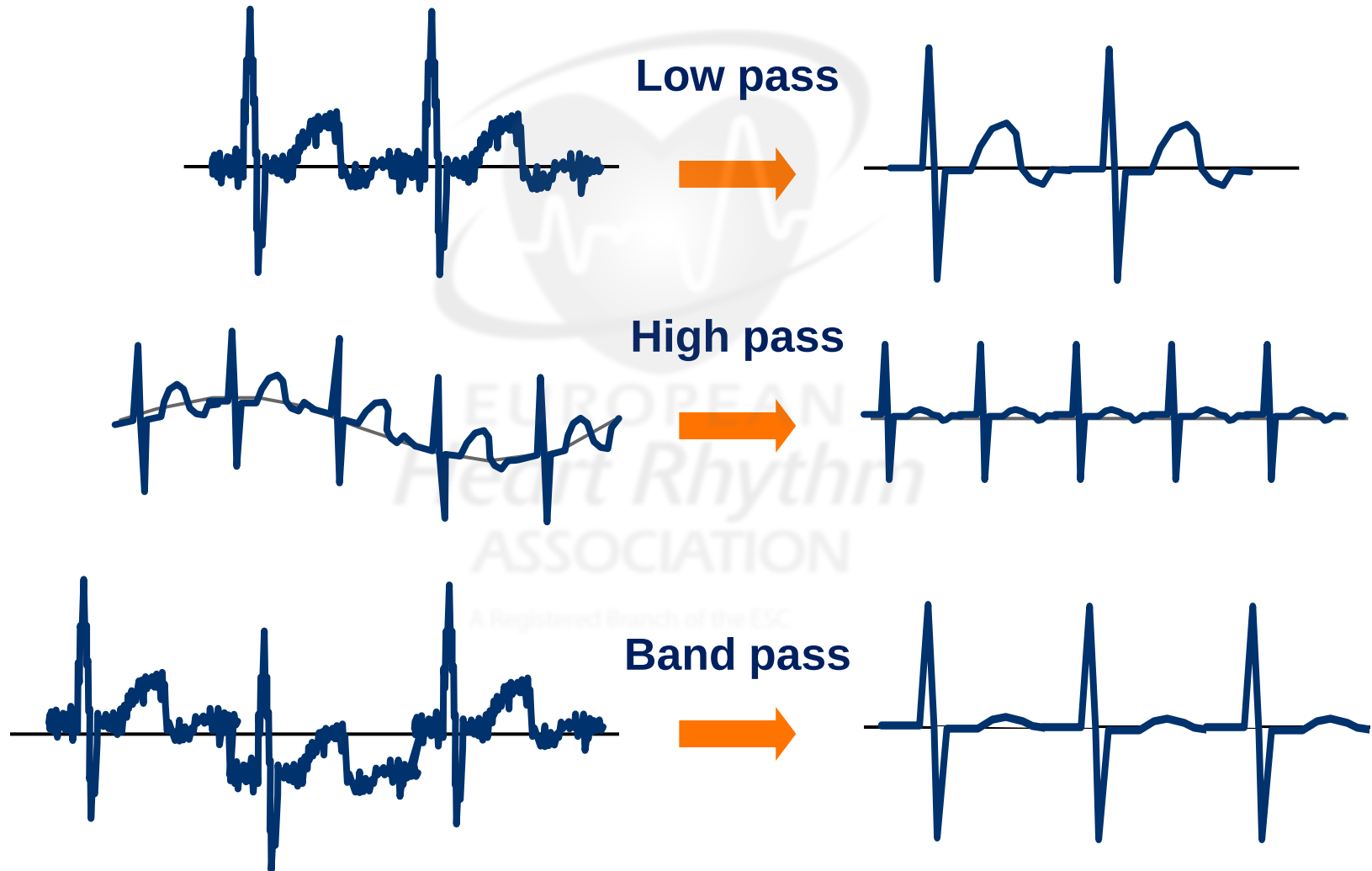


Tip-ring
bipolar



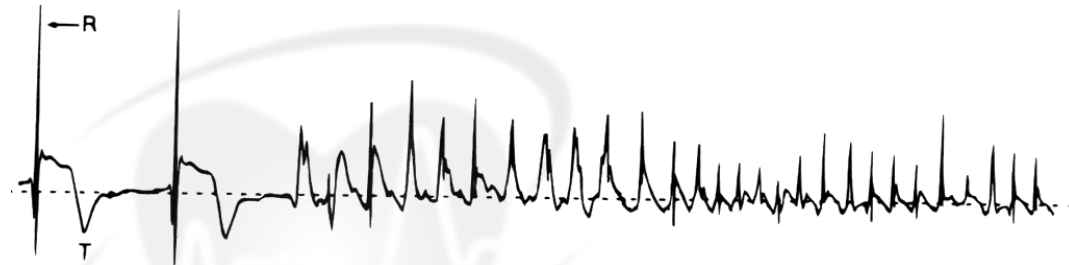
Integrated
bipolar

ICD Signal Filtering

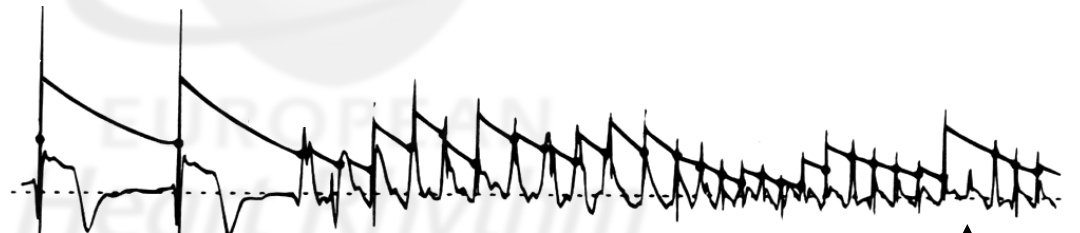


ICD Sensing

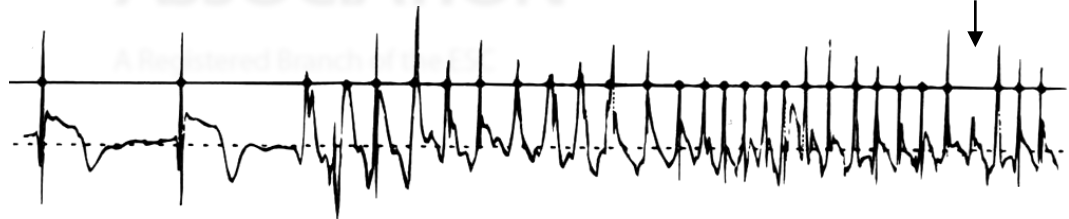
Intracardiac
electrogram
(IEGM)



Automatic
threshold
adjustment

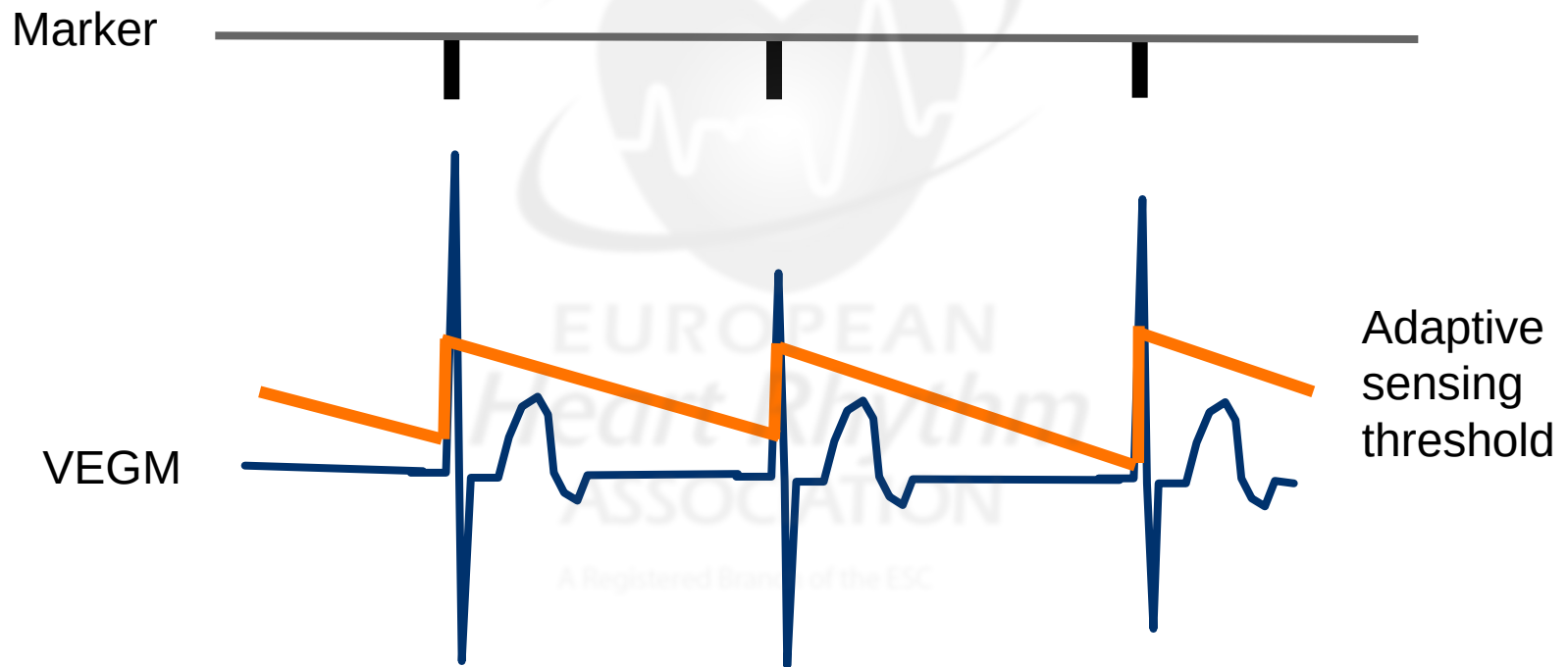


Automatic
gain control/
fixed threshold

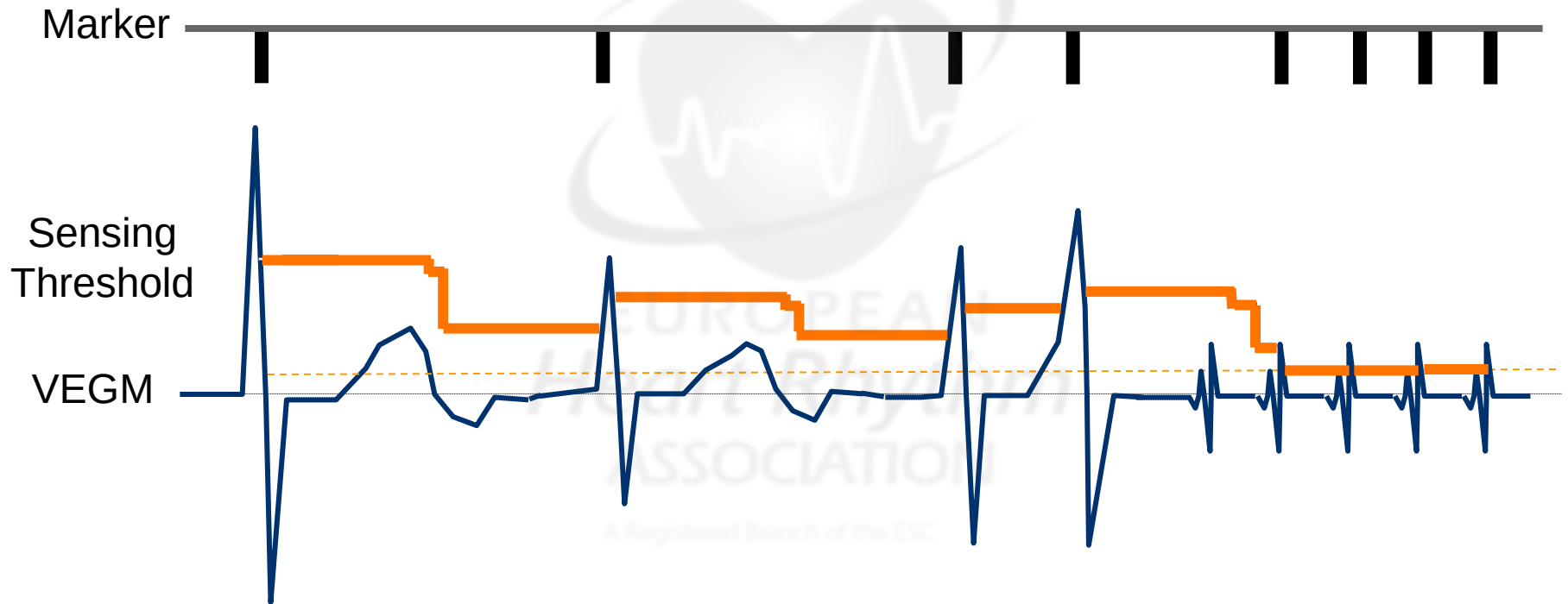


undersensing
↑
↓

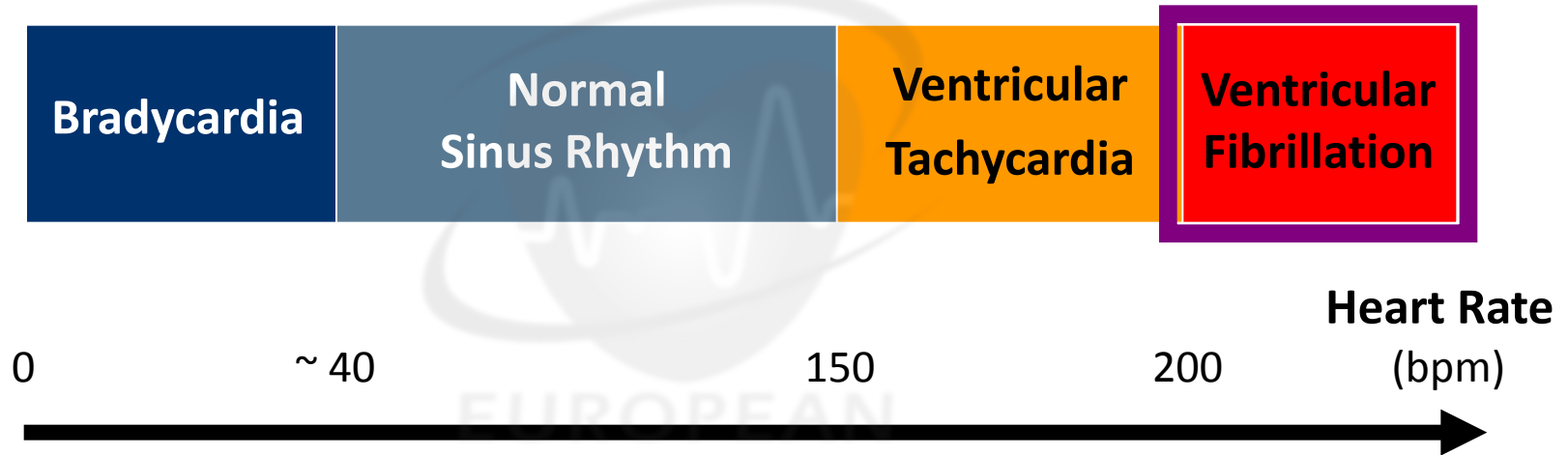
ICD Event Detection



ICD Event Detection

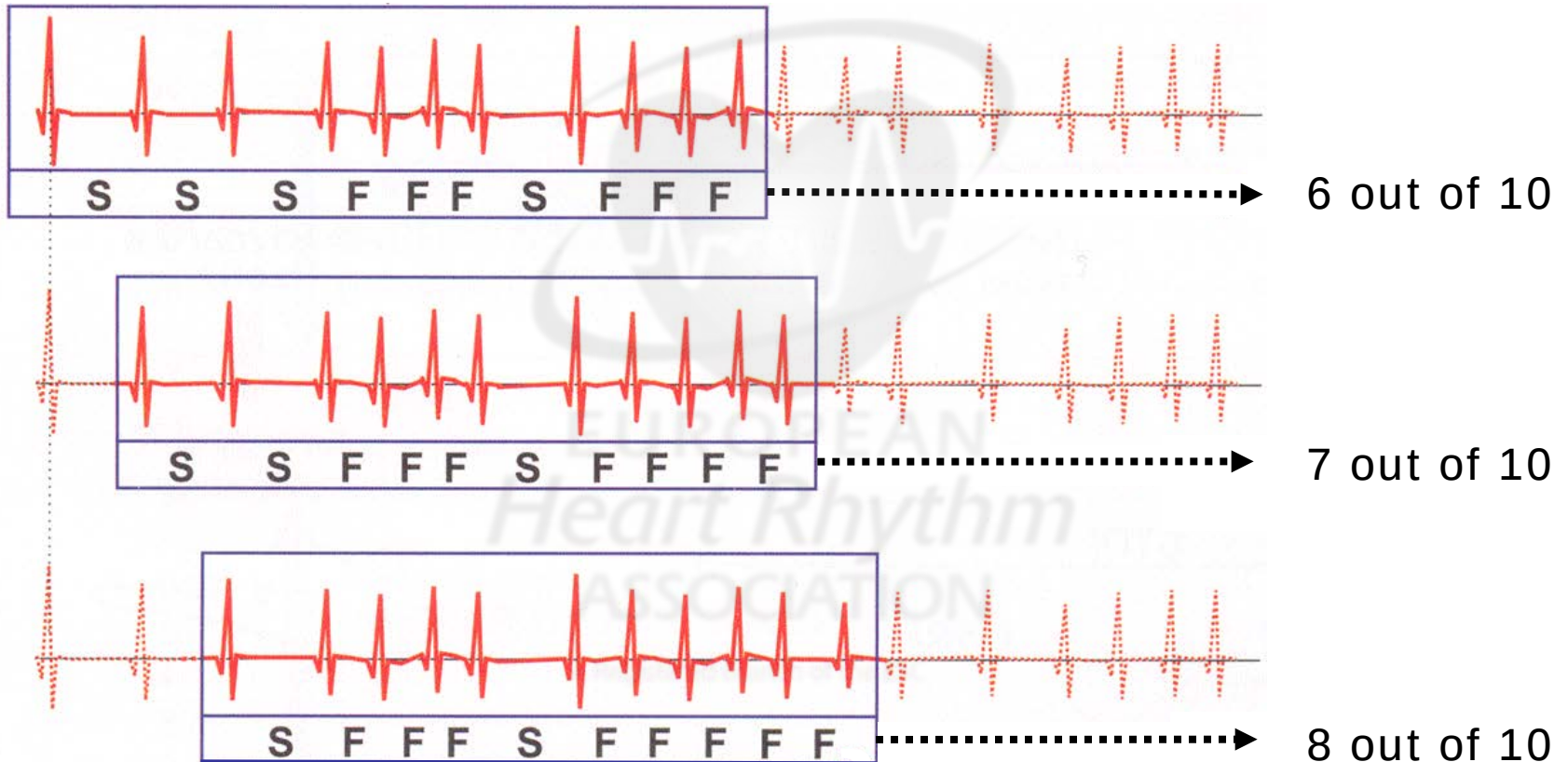


ICD Detection Zones



EUROPEAN
Heart Rhythm
ASSOCIATION
A Registered Branch of the ESC

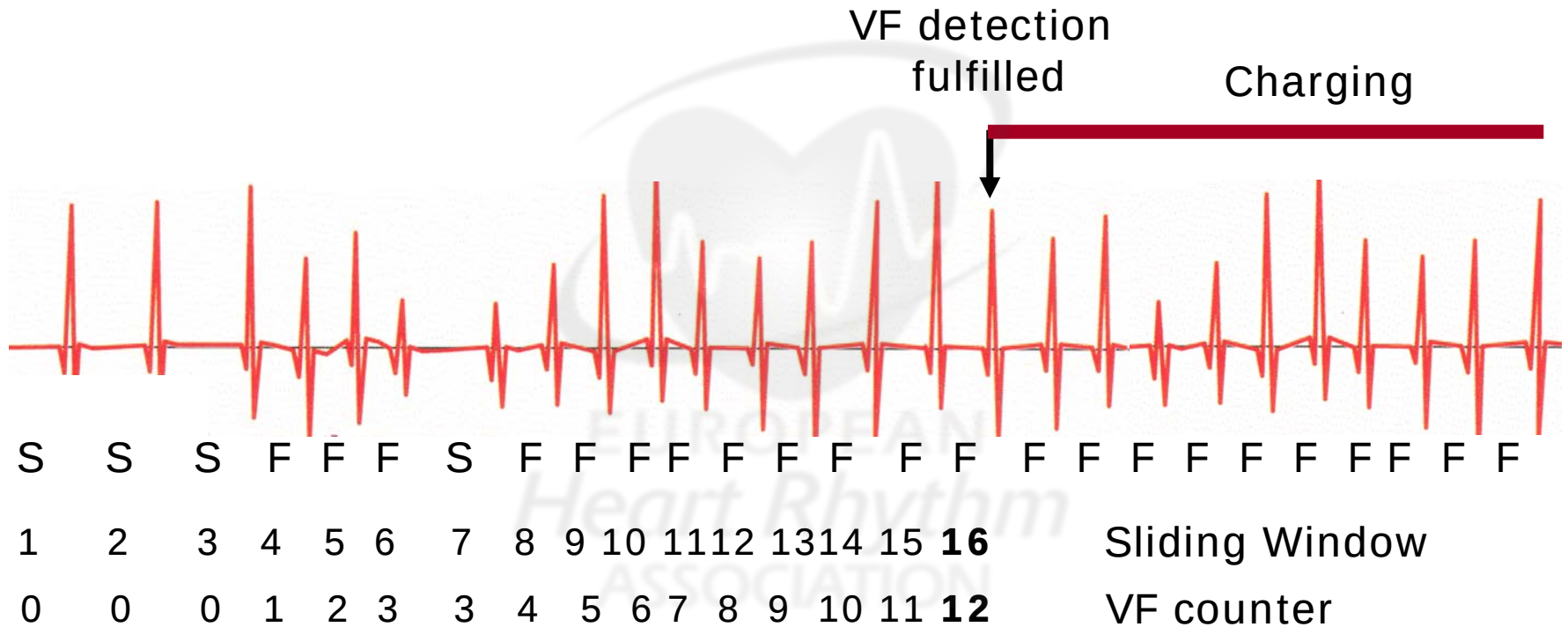
VF Detection



F = fast
S = slow

Sliding VF Detection Window

VF Detection



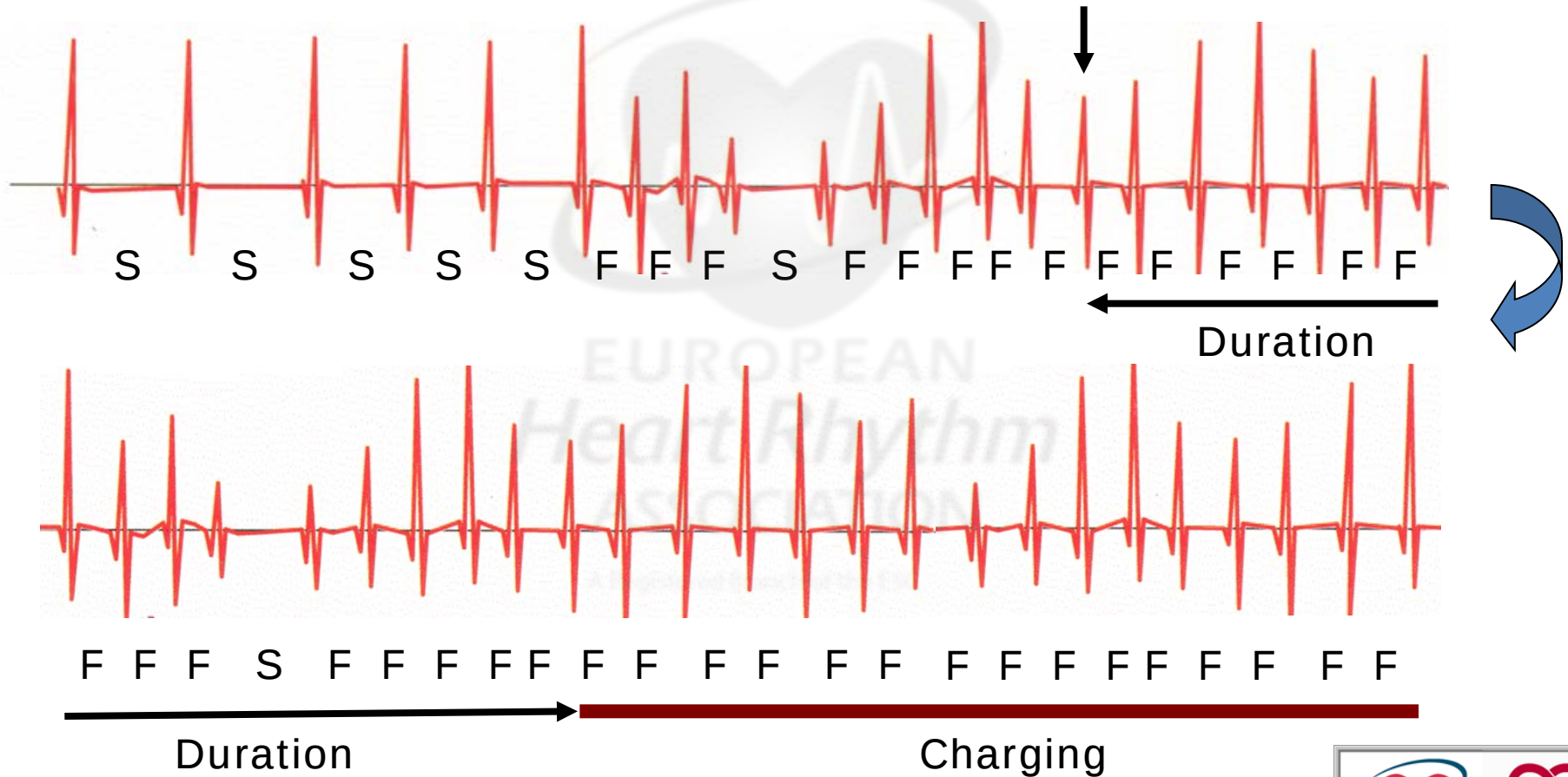
F = fast
S = slow

X out of Y: 12/16

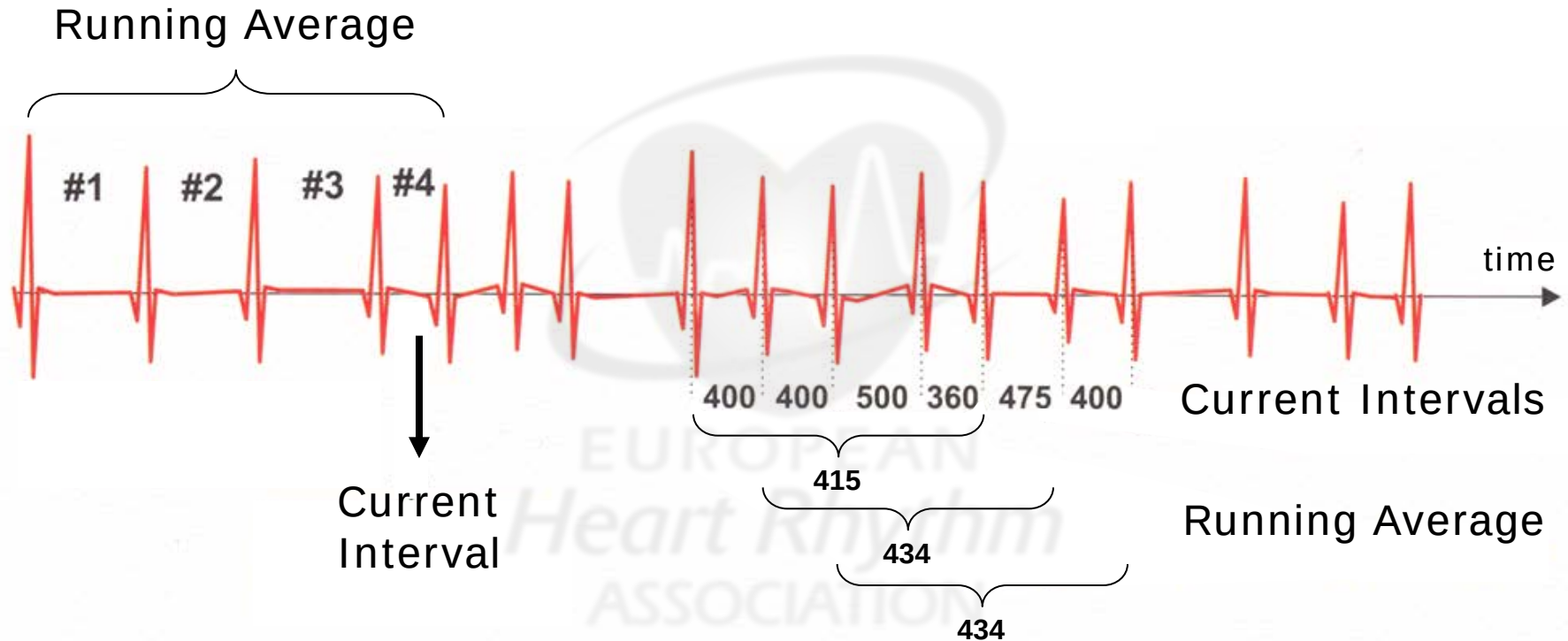
VF Detection

F = fast S = slow

Initial detection 8/10

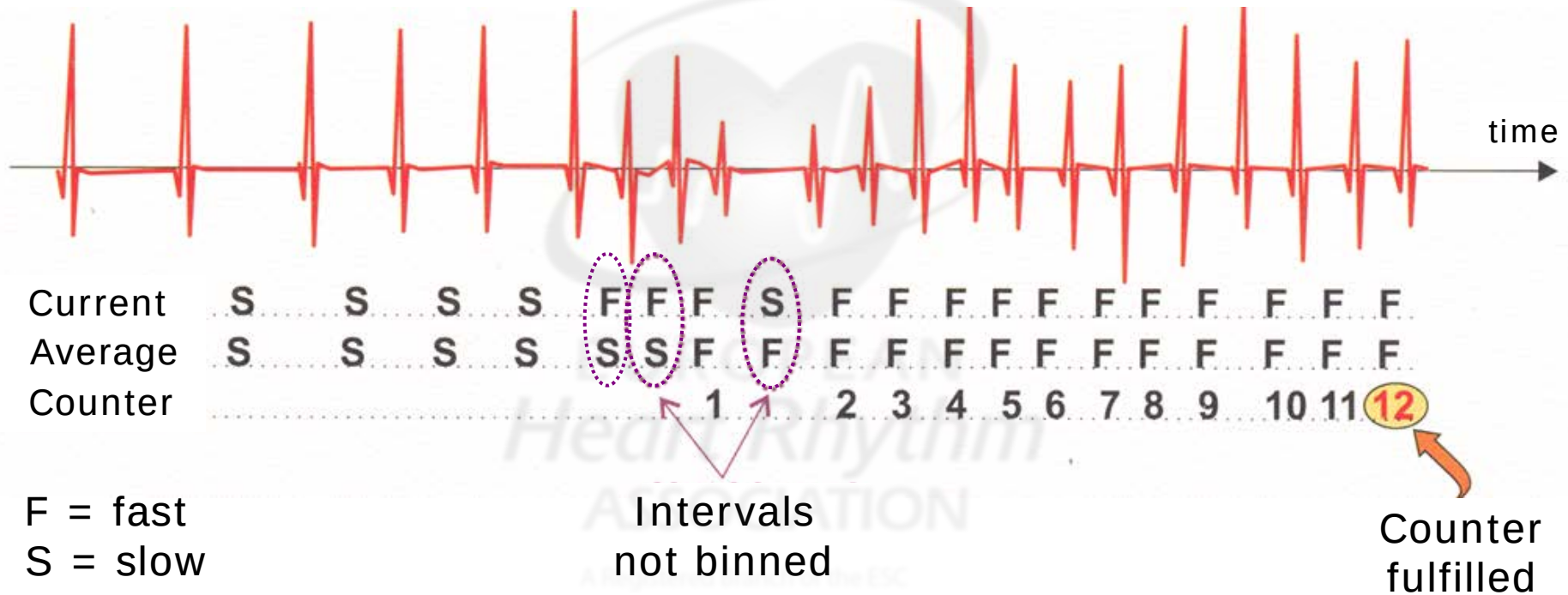


VF Detection



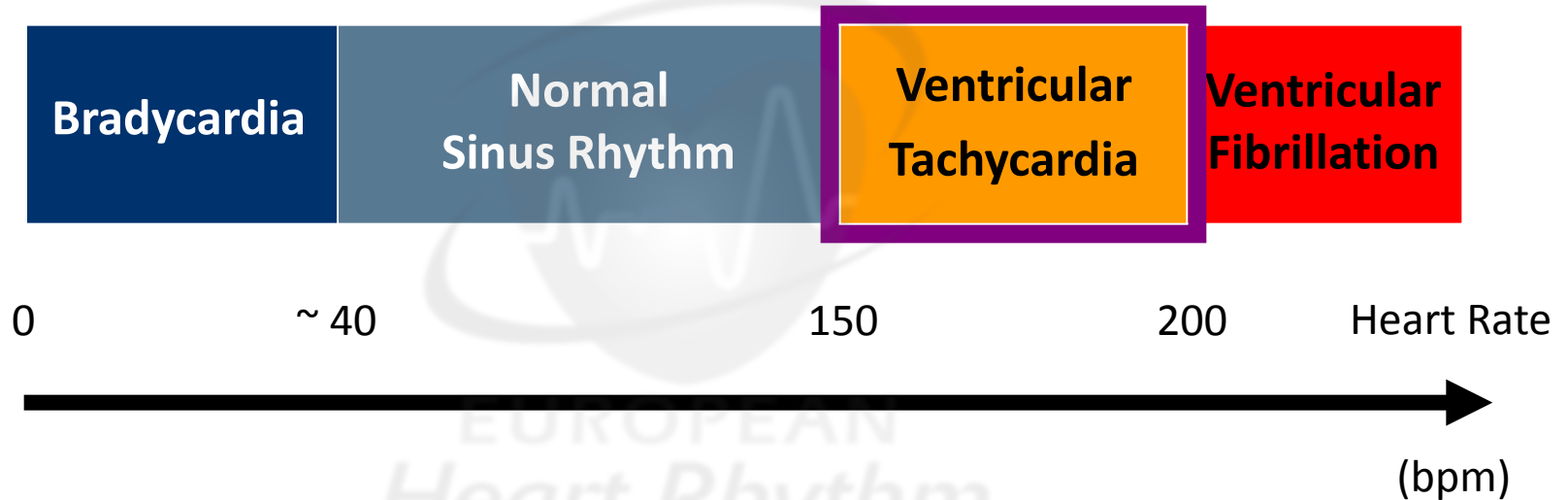
Binning Criteria

VF Detection



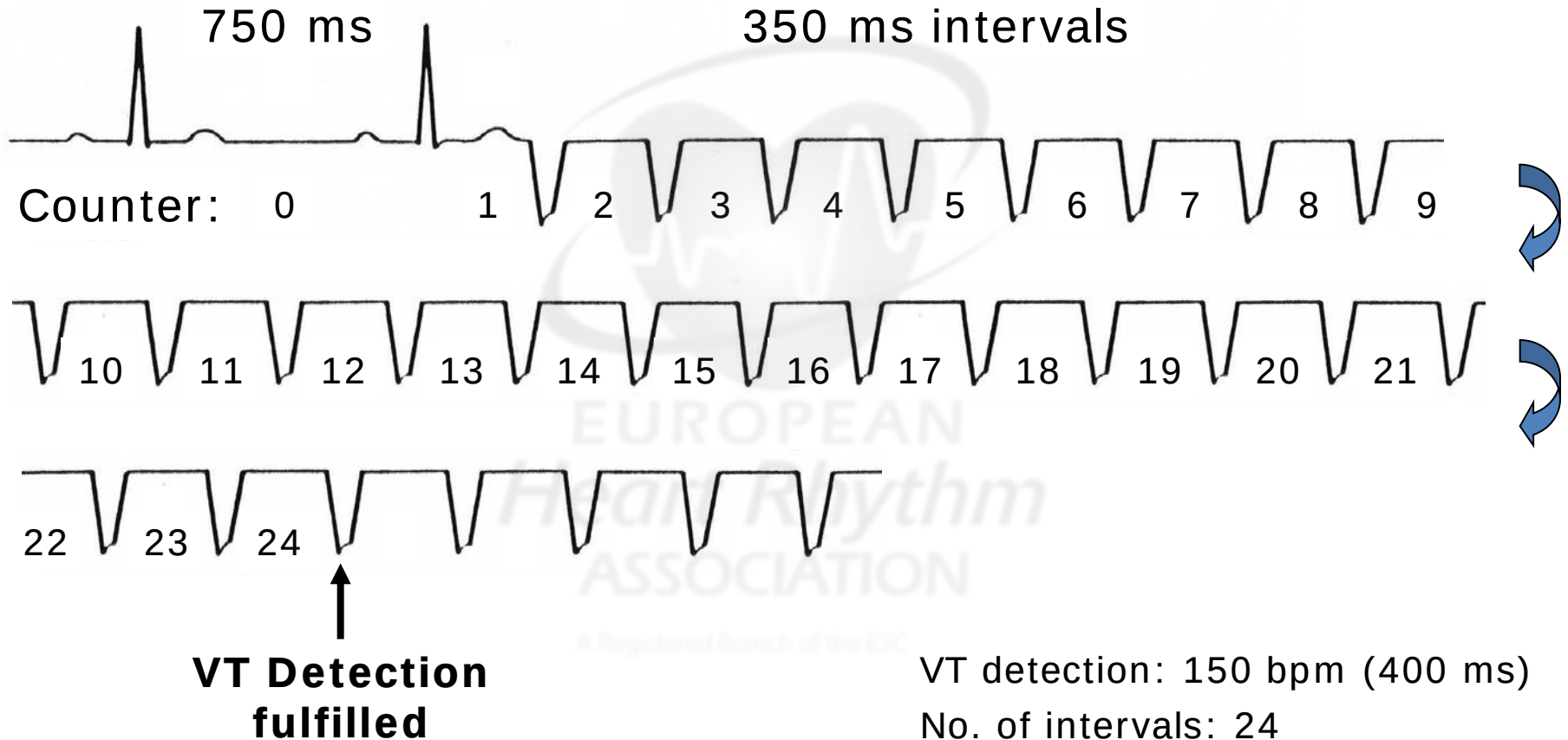
Binning Criteria

ICD Detection Zones



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VT Detection



Inhibiting Detection Criteria

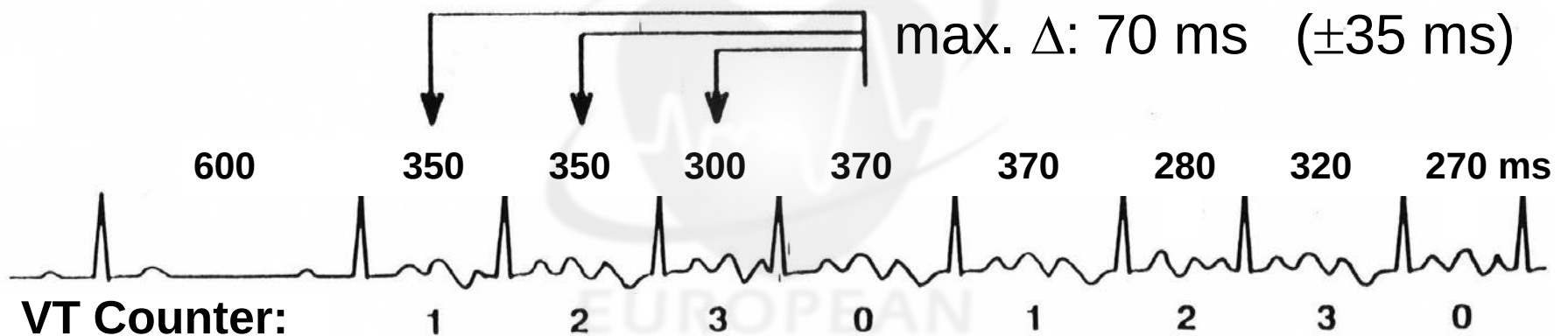
- Stability
- Onset
- Sustained high rate
- Morphology
- Dual chamber detection

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Atrial Fibrillation



Stability Criteria



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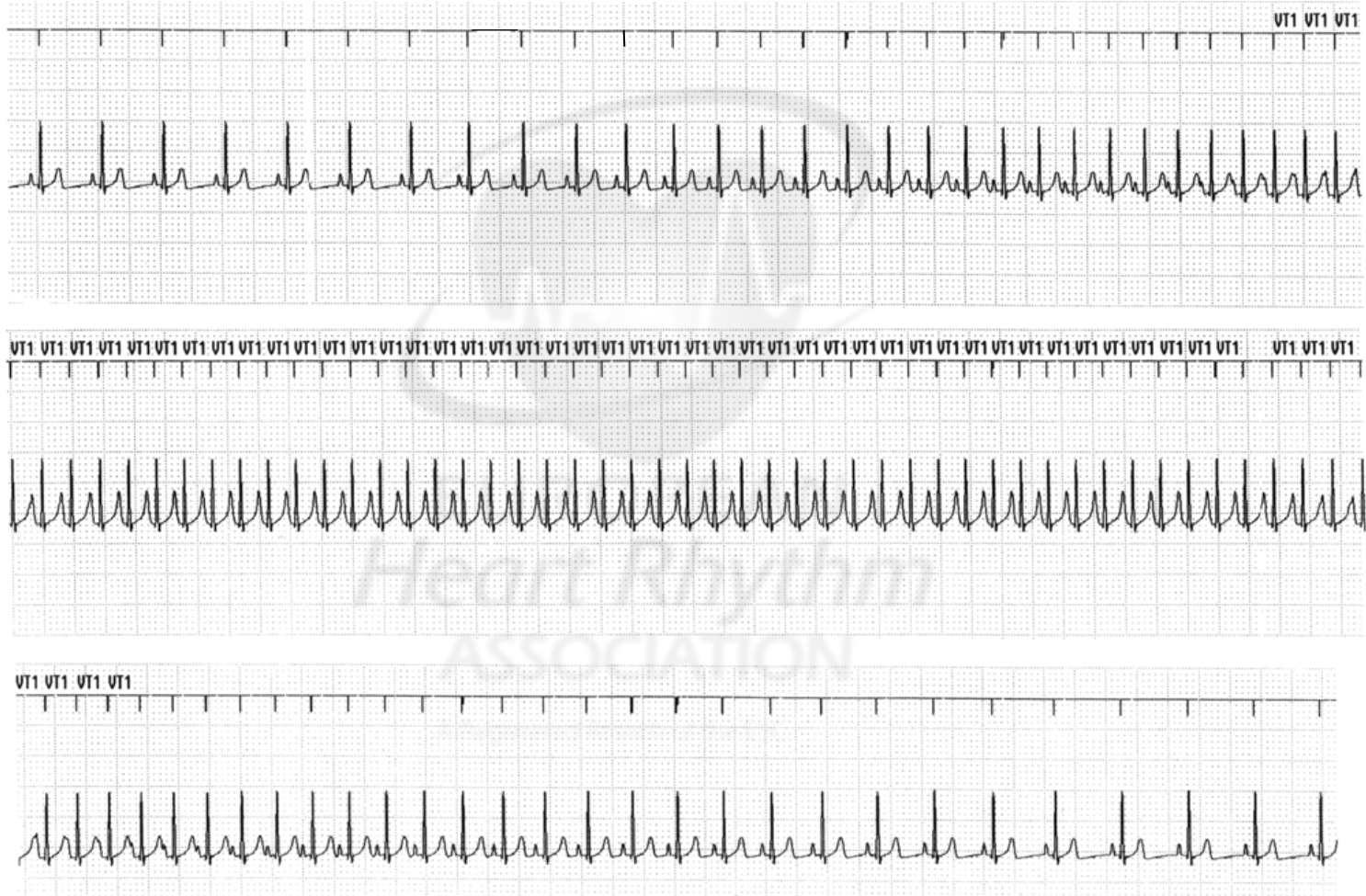
Stability Criteria

Potential Difficulties

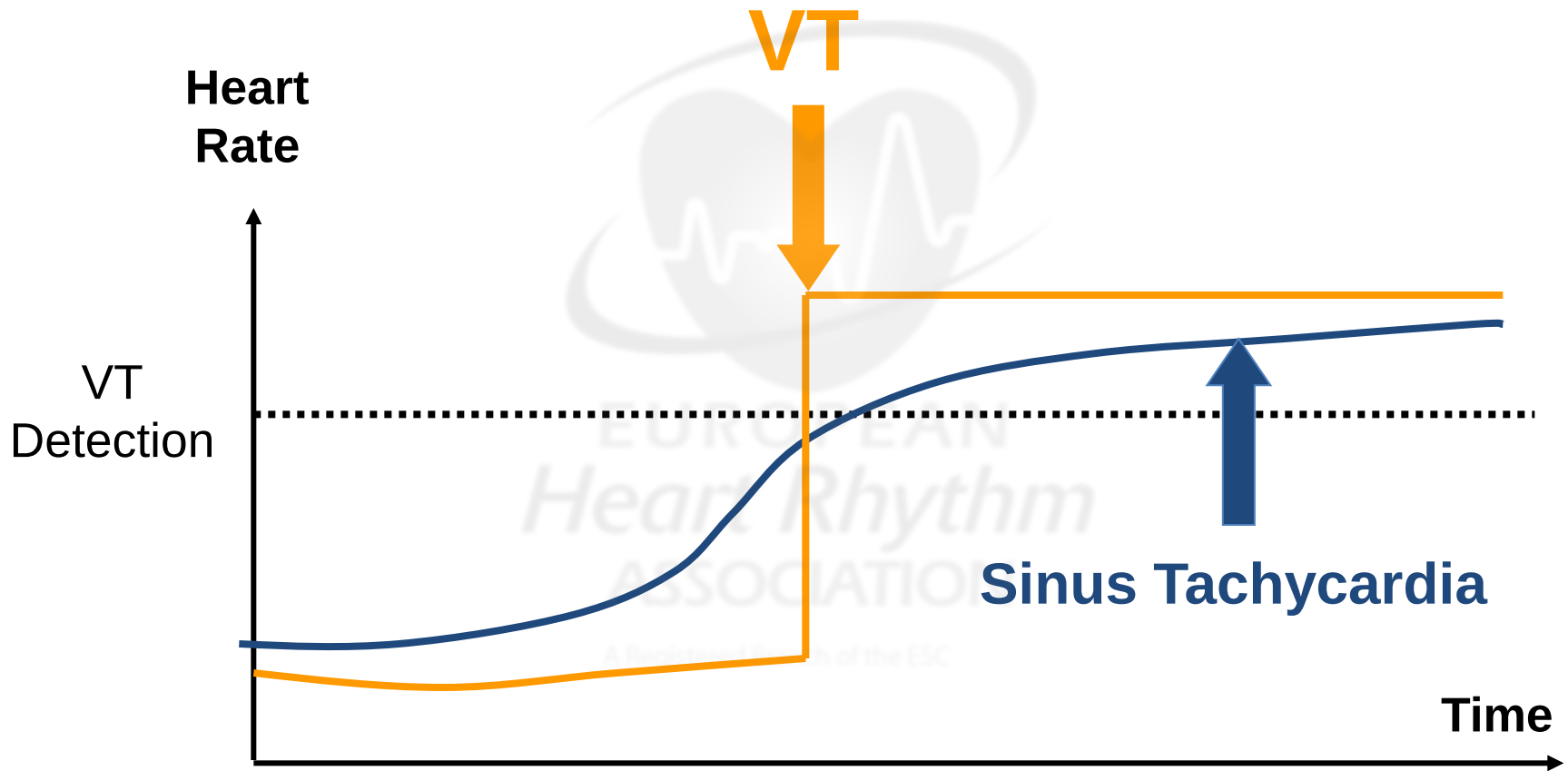
- AFib with fast conduction >160 bpm
- Slowing of polymorphic VTs under AA drugs

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Heart Rhythm
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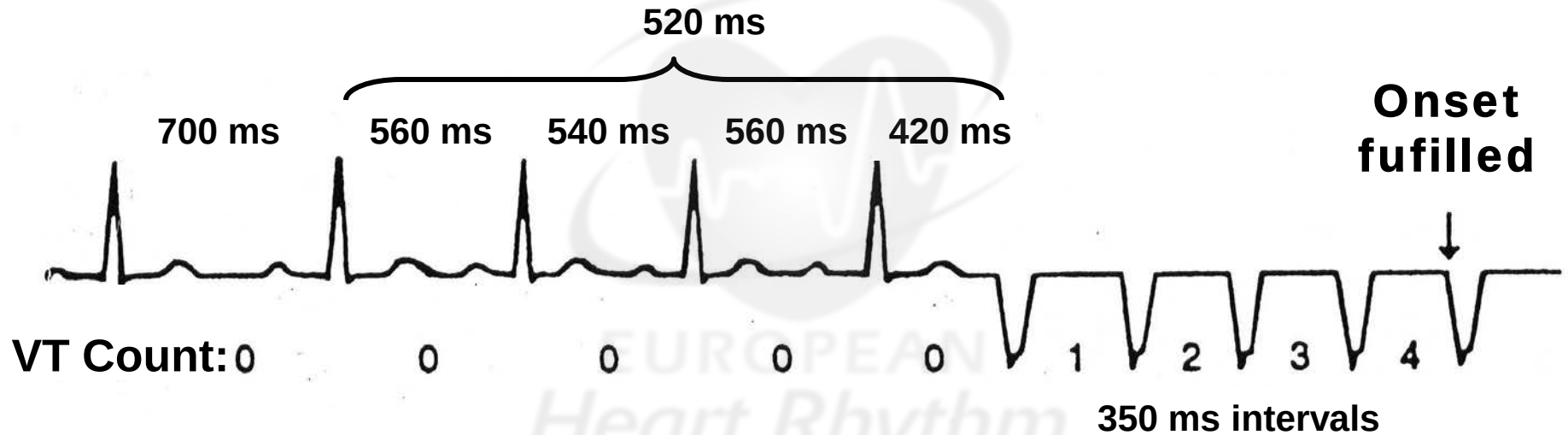
Sinus Tachycardia



Onset Criteria



Onset Criteria



Calculation of Onset

$$520 - 350 / 520 = 33 \%$$

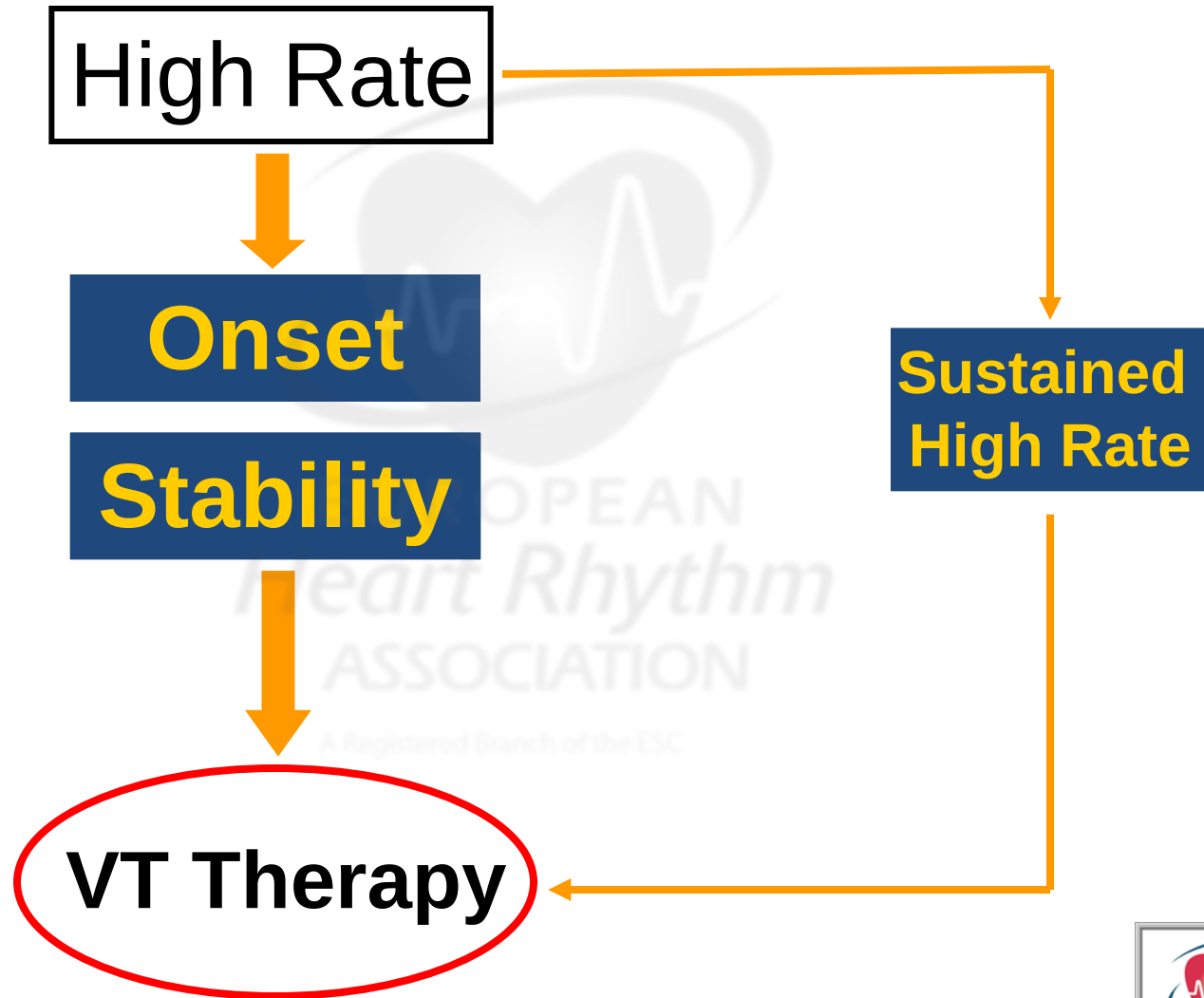
$$350 / 520 = 67 \%$$

Onset Criteria

Potential Difficulties

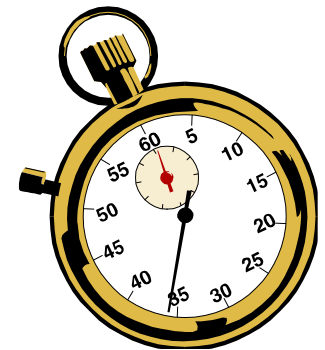
- VT starts during sinus tachycardia
- Slow VT accelerates from rates below the detection zone

VT Detection



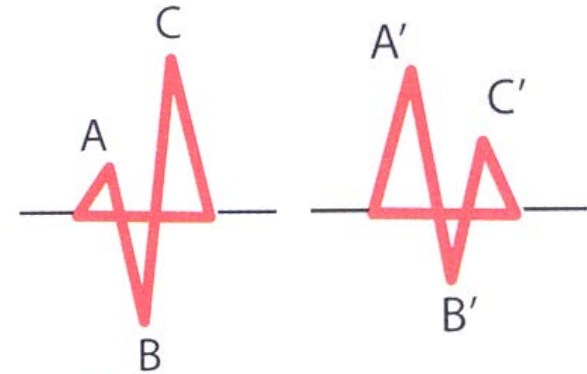
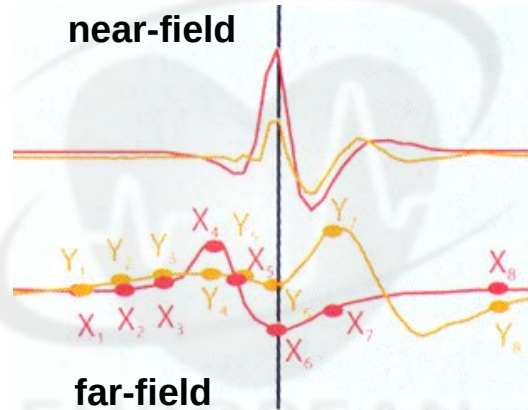
Sustained High Rate

- Typical setting: 3 (better 5) to 10 min in relation to hemodynamic tolerance
- Maintains 100% VT sensitivity with onset
- Risk of inappropriate therapy in AF

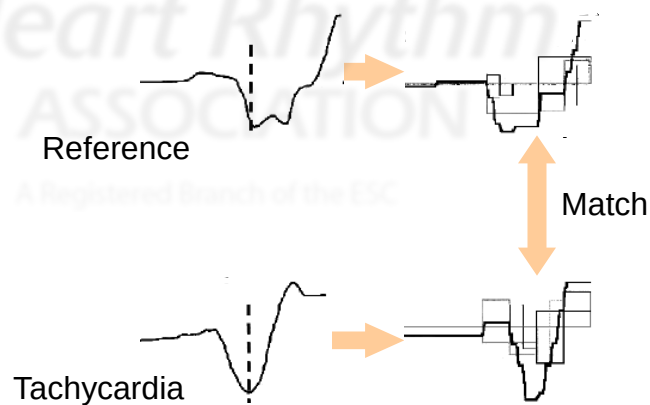


Morphology Criteria

- Templates



- Wavelets



Frequent
template
updates
necessary

Morphology Criteria

Potential Difficulty

Increase in specificity on the price of a decrease in sensitivity for VT detection

Update may be compromised by

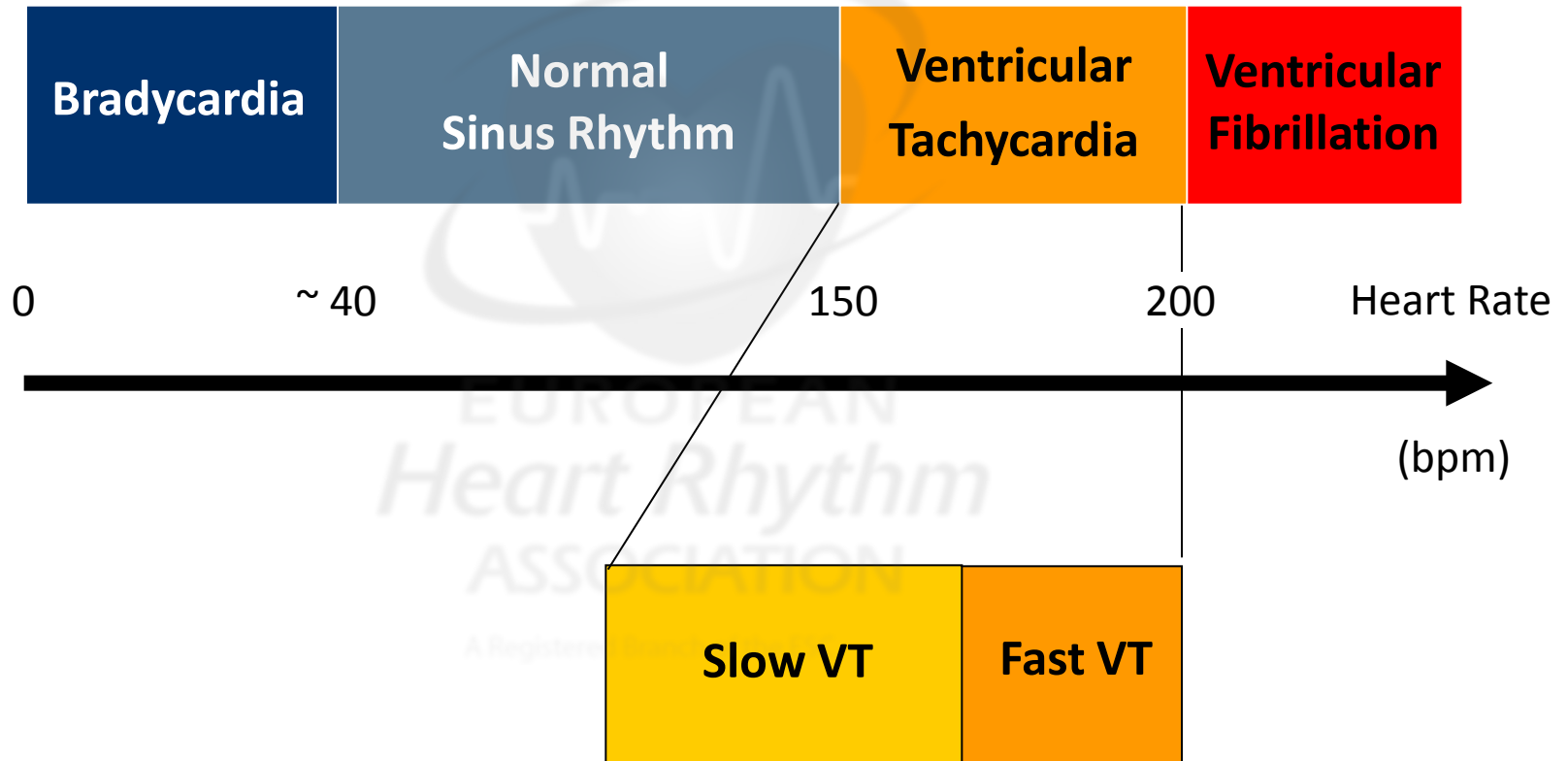
- Wide QRS
- Rate dependent BBB
- Frequent need of pacing

Inhibiting Detection Criteria

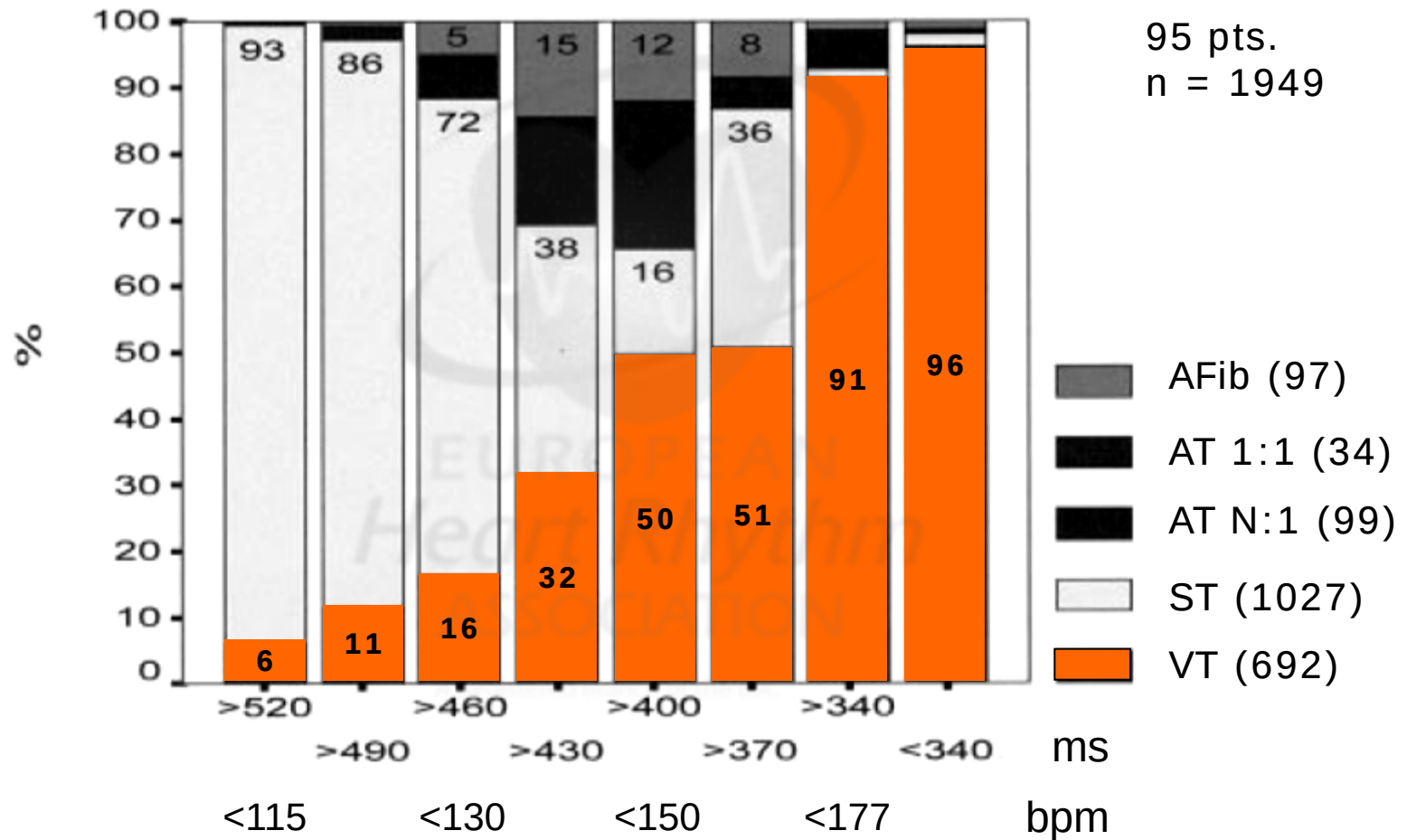
- Stability
- Onset
- Morphology
- **Dual chamber detection**



ICD Detection Zones



Tachycardia Episodes



Bänsch D et al., Circulation 110 (2004) 1022-1029

Dual-Chamber Detection

V Rate is in VT Zone



V Rate vs. A Rate



$V > A$



VT/VF



$V < A$



?



$V = A$

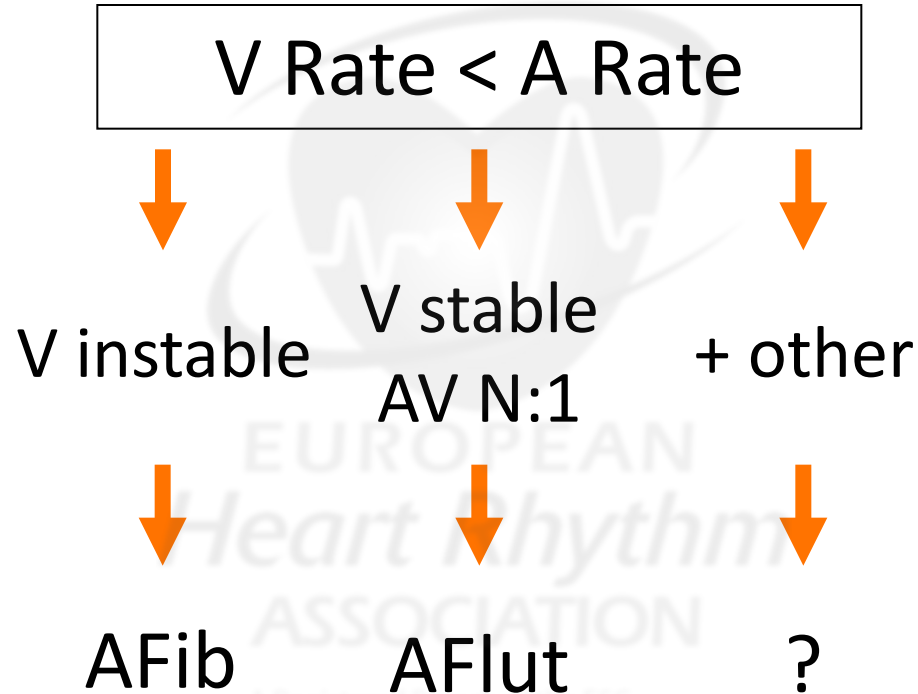


?

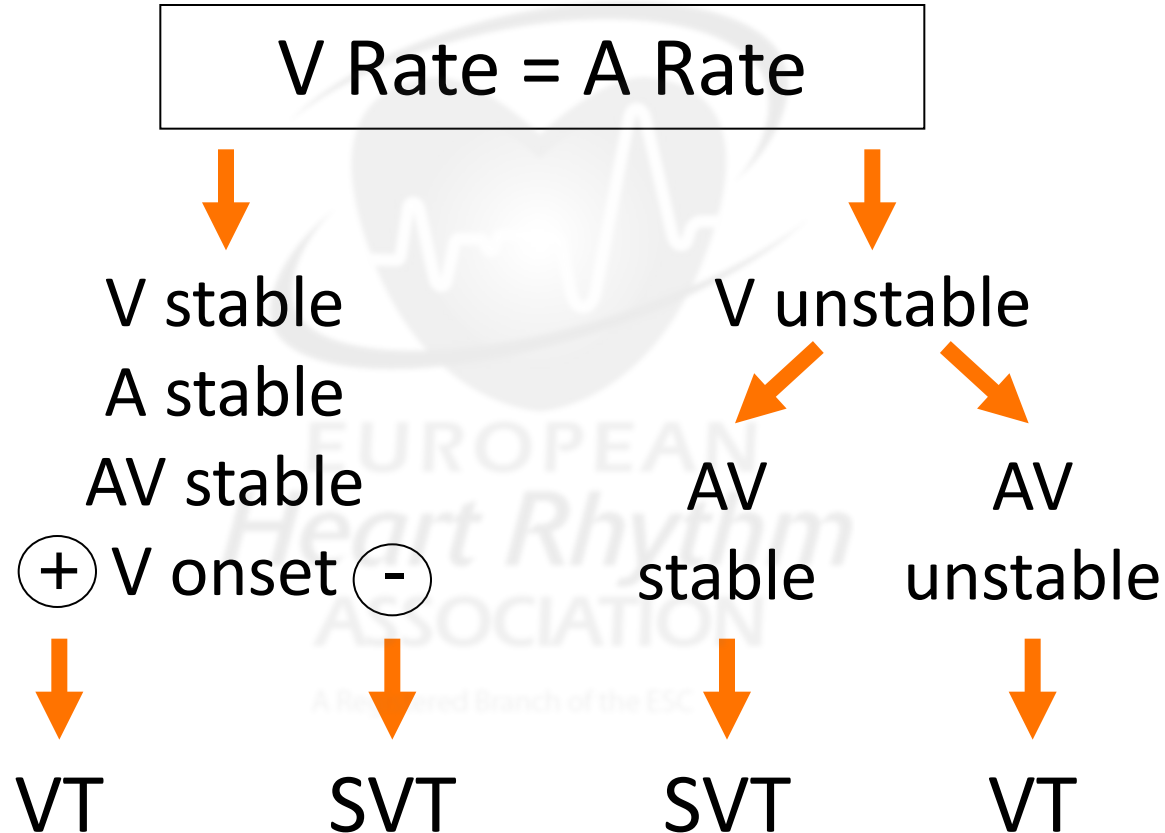
ICD Detection Criteria

- Atrial + ventricular
- Onset, stability
- Sustained high rate
- AV association
- Morphology
- P-R patterns

Dual-Chamber Detection



Dual-Chamber Detection



ICD Detection Algorithms

$$\text{Sensitivity} = \frac{\text{Detected VTs (ICD)}}{\text{All clinical VTs (Patient)}}$$

$$\text{Specificity} = \frac{\text{Detected SVTs (ICD)}}{\text{All clinical SVTs (Patient)}}$$



Increase specificity without compromising sensitivity!

Dual-Chamber Detection

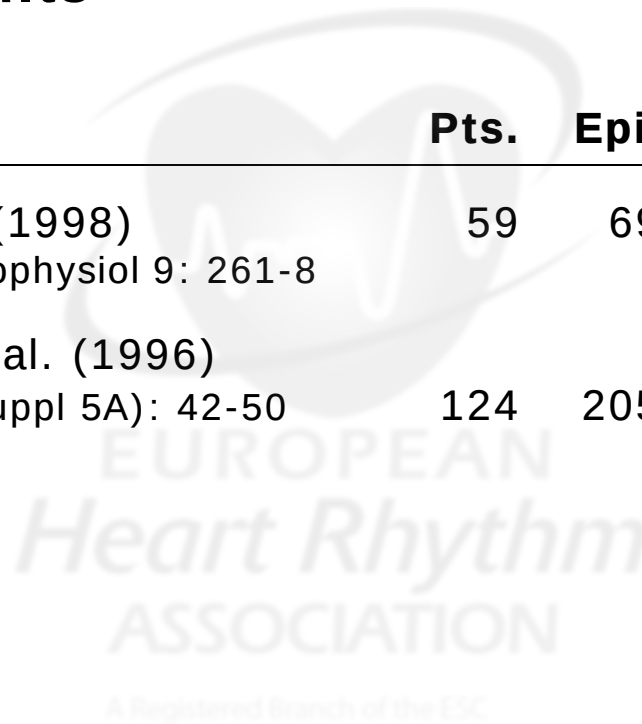
Clinical Results

Author	Pts.	Epis.	Sens.	Spec.
Schoels W et al. (2001) J Cardiovasc Electrophysiol 12: 521-8	293	1056	100%	89%
Wilkoff B et al. (2001) Circulation 103: 381-6	933	4856	100%	88%
Sadoul N et al. (2002) J Cardiovasc Electrophysiol 13: 25-32	95	559	100%	92%
Bailin SJ et al. (2003) J Cardiovasc Electrophysiol 14: 144-9	107	160	100%	84%
Sinha AM et al. (2004) J Cardiovasc Electrophysiol 15: 646-52	209	1245	100%	90%

Single-Chamber Detection

Clinical Results

Author	Pts.	Epis.	Sens.	Spec.
Brugada J et al. (1998) J Cardiovasc Electrophysiol 9: 261-8	59	690	100%	83%
Schaumann A et al. (1996) Am J Cardiol 78 (Supl 5A): 42-50	124	2053	100%	95%



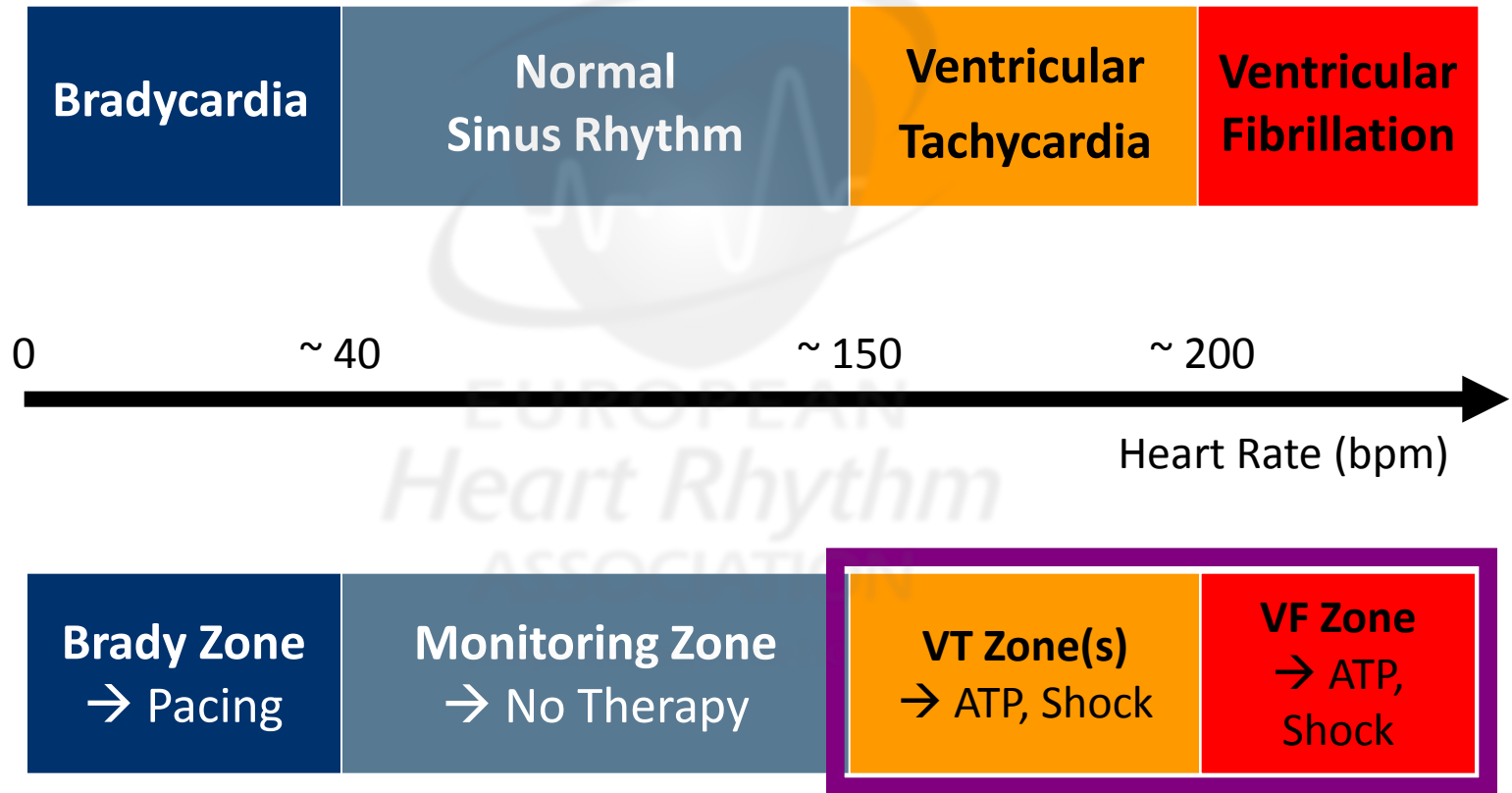
Dual-Chamber Discrimination

Conclusions from Meta-Analysis

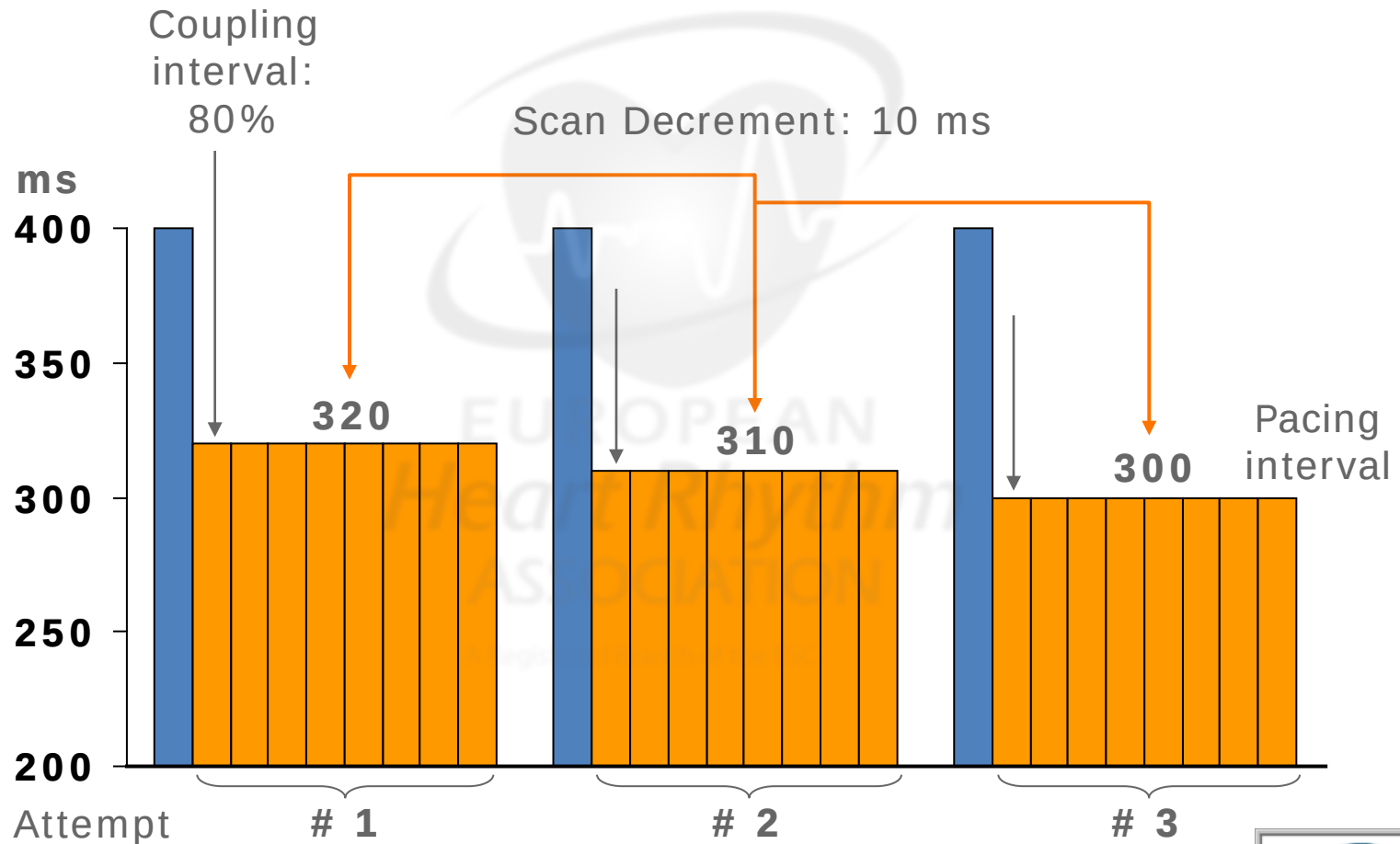
- It significantly reduces the number of inappropriately treated atrial episodes compared to single-chamber devices.
- However, the amount of patients receiving inappropriate therapies was similar between groups.

Theuns D et al., Int J Cardiol 125 (2008) 352–357

ICD Detection and Therapy



Antitachycardia Pacing - Burst



Antitachycardia Pacing - Burst

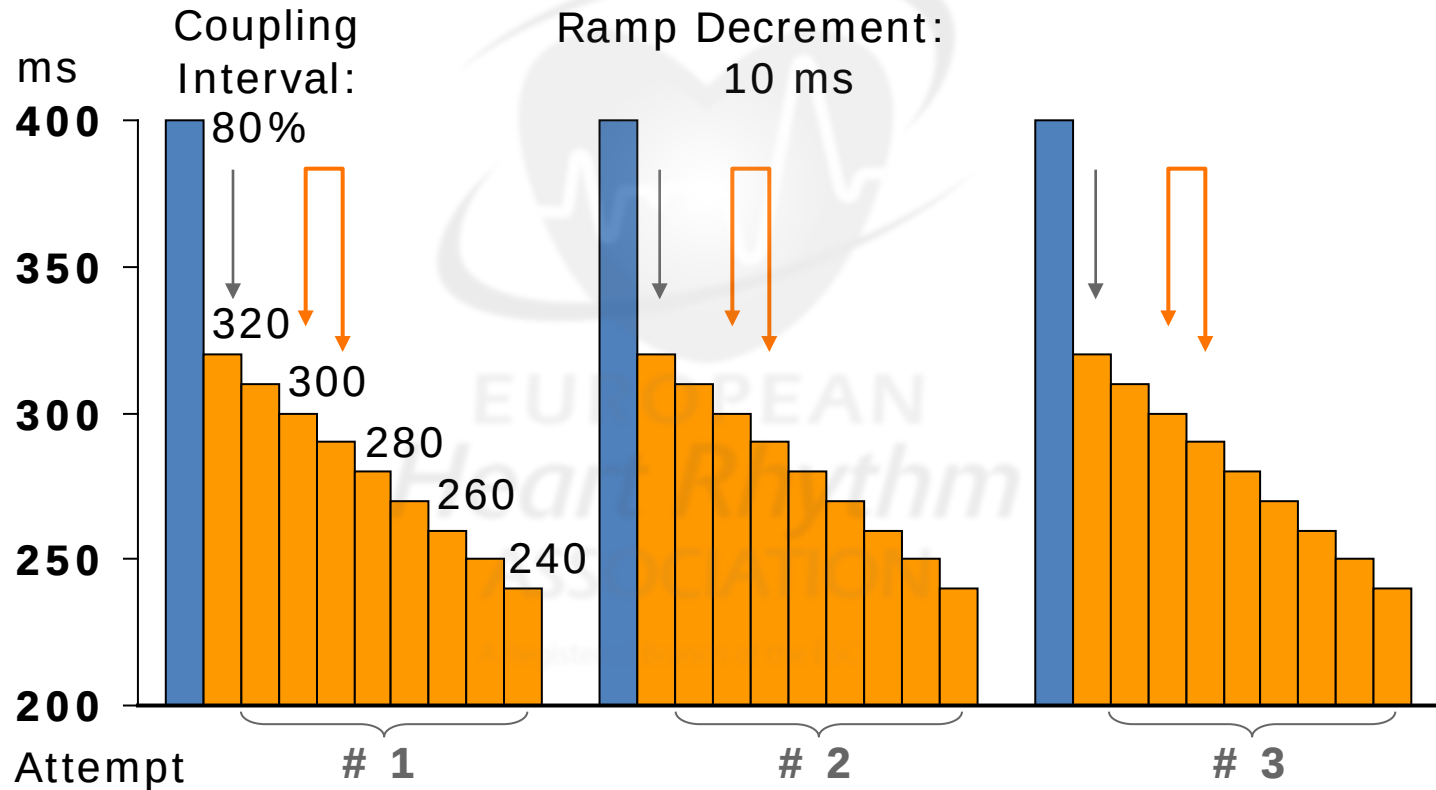
No. of attempts: 3

Coupling Interval: 80%

No. of pacing cycles: 8

Scan decrement: 10 ms

Antitachycardia Pacing - Ramp



Antitachycardia Pacing - Ramp

No. of attempts: 3

Coupling Interval: 80%

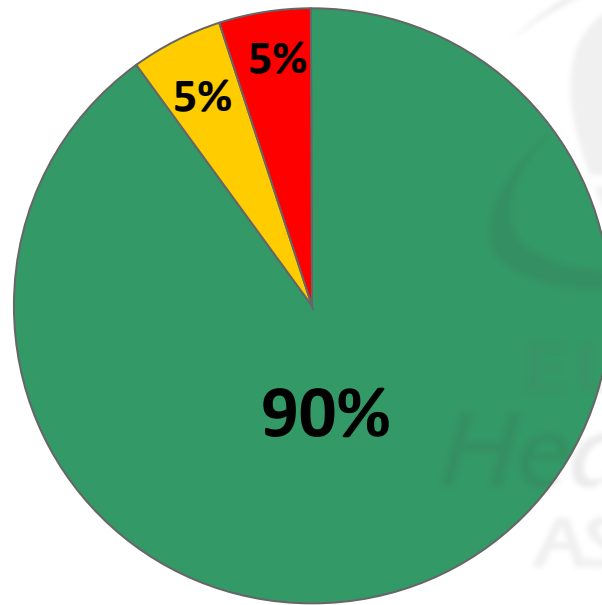
No. of pacing cycles: 8-10

Ramp decrement: 8 ms

Antitachycardia Pacing - Ramp

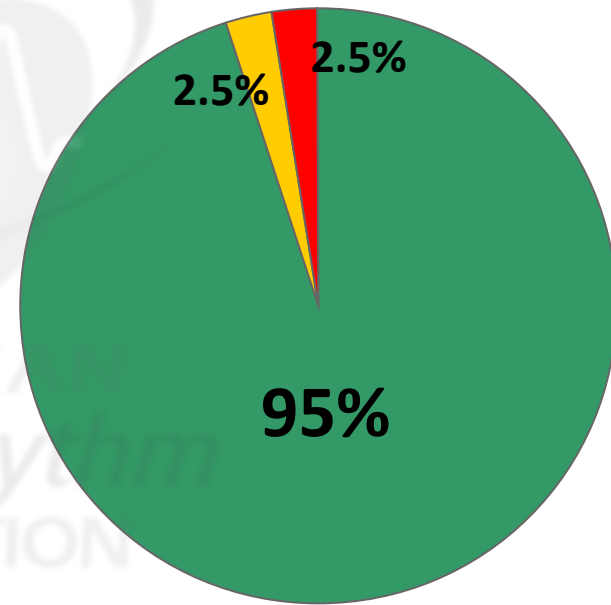
Empiric ATP

81 pts. with 1346 eps.



EP Tested ATP

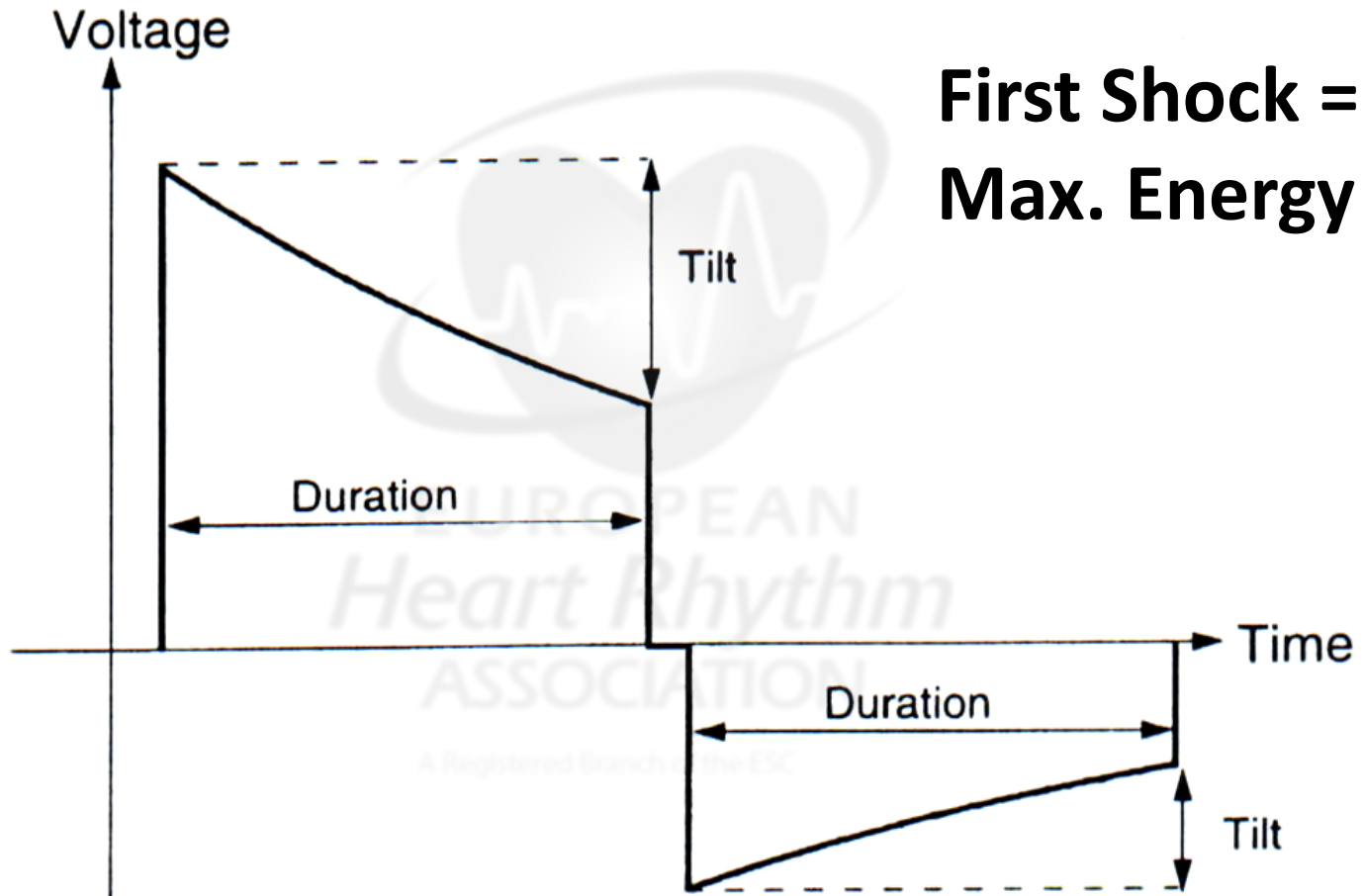
42 pts. with 3819 eps.



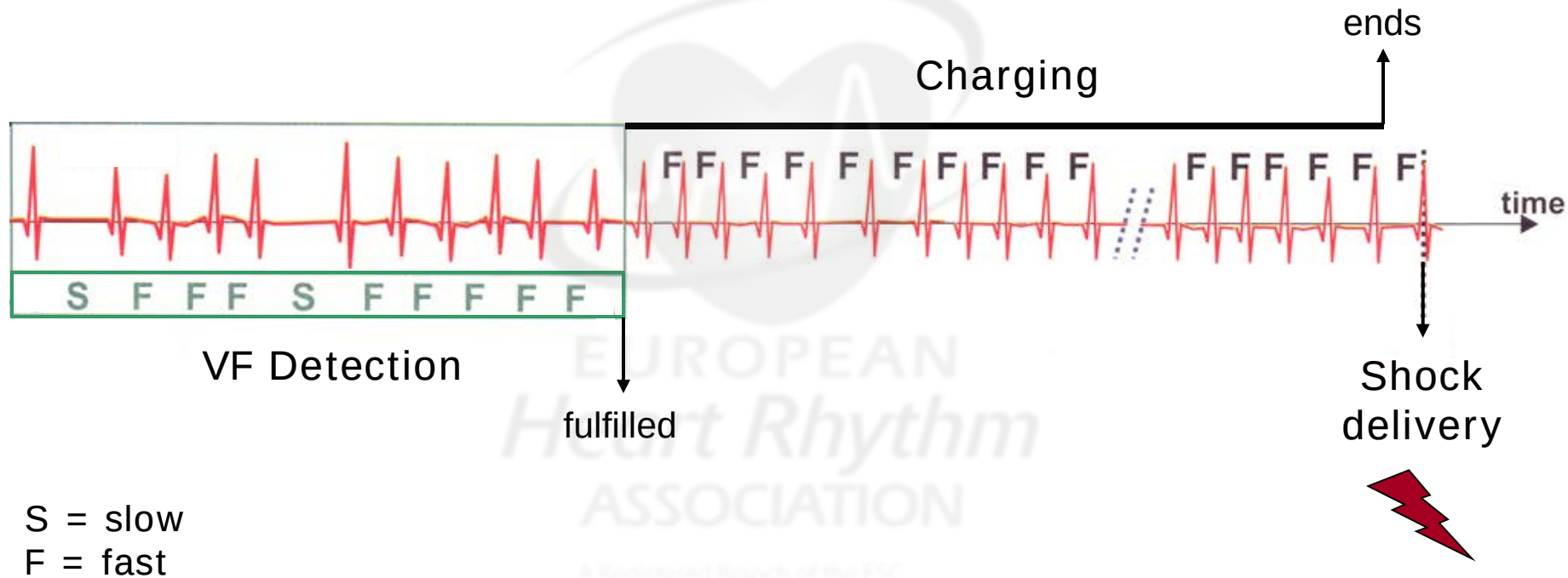
■ Terminated ■ Unchanged ■ Accelerated

Schaumann A et al., Circulation 97 (1998) 66–74

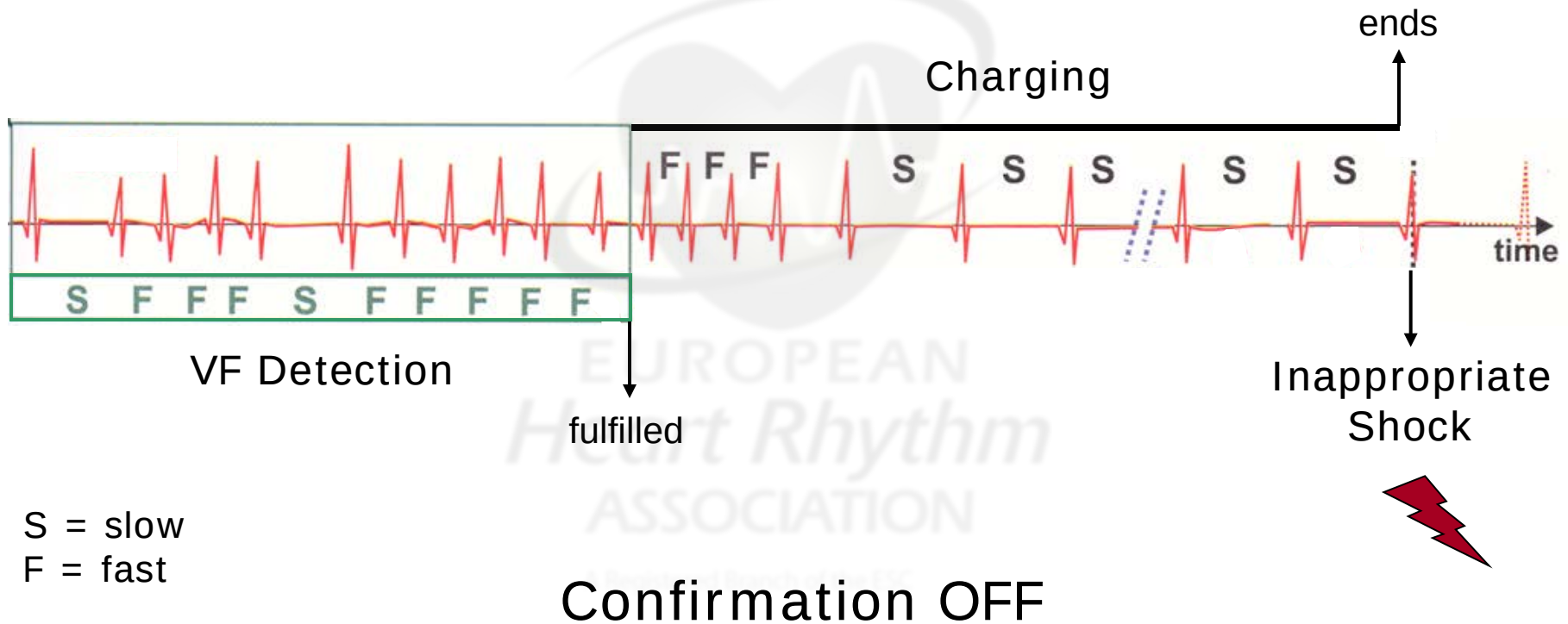
ICD Biphasic Shock



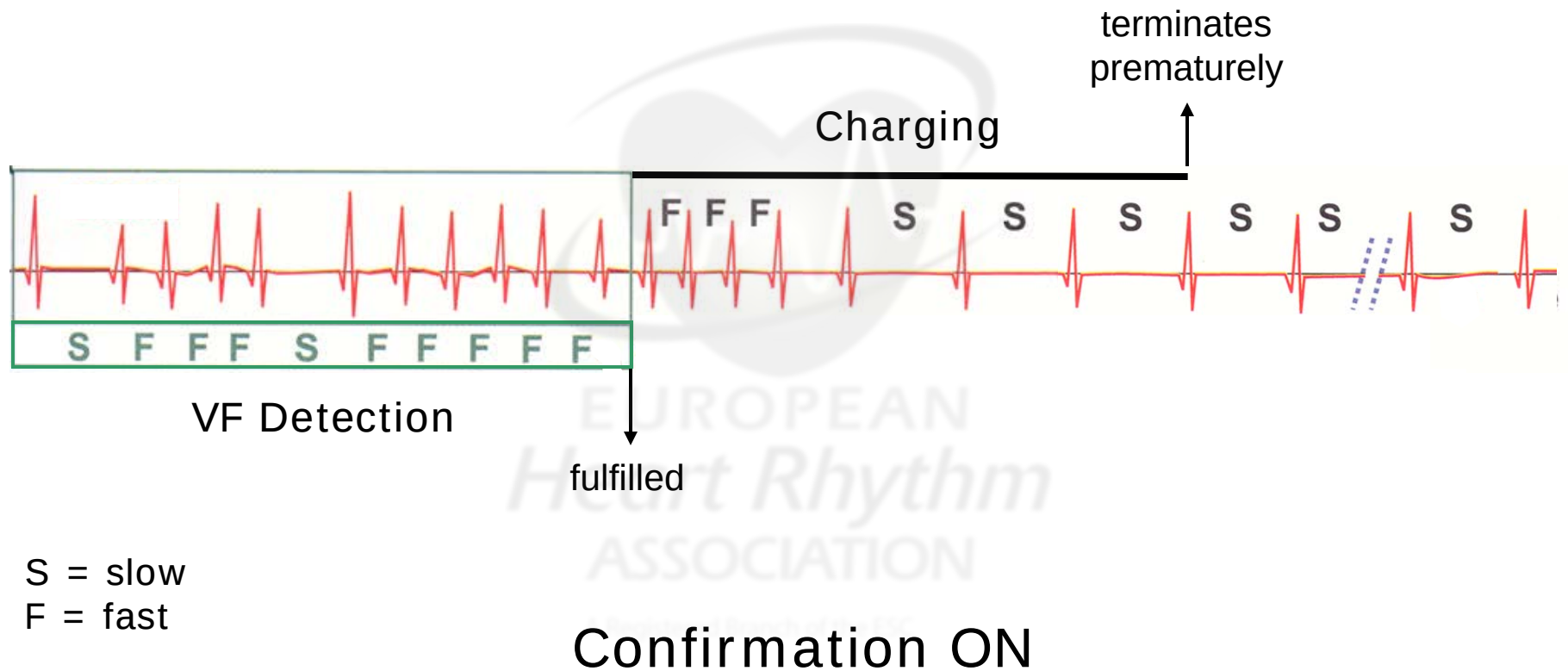
ICD Shock



Committed ICD Shock



Non-committed ICD Shock



Specific ICD Programming

History of Arrhythmias

- Rate of spontaneous/induced VTs
- Max. heart rate during exercise
- History of AF/SVT, bradyarrhythmias
- BBB, intrinsic PR interval

Cardiac Disease, LV Function

Hemodynamic tolerance

Medication

Recent or planned change in AA drug

Specific ICD Behavior

- Sensing
- Detection
- Therapy

